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(71) Applicant
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(54) Impeller Blades

(57) Narrow members such as 20 are disposed at the tips of fan blades 3 and extend generally at right angles to the latter so as to prevent flow losses around the tips.

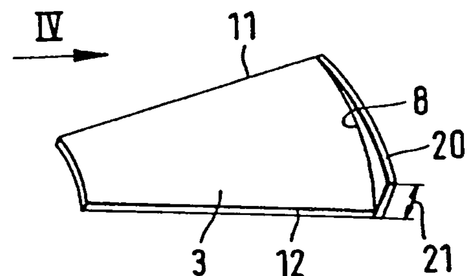

FIG. 3

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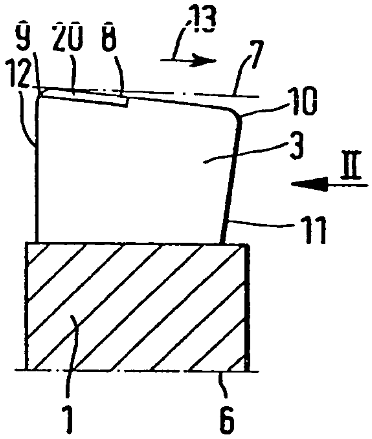

FIG. 1

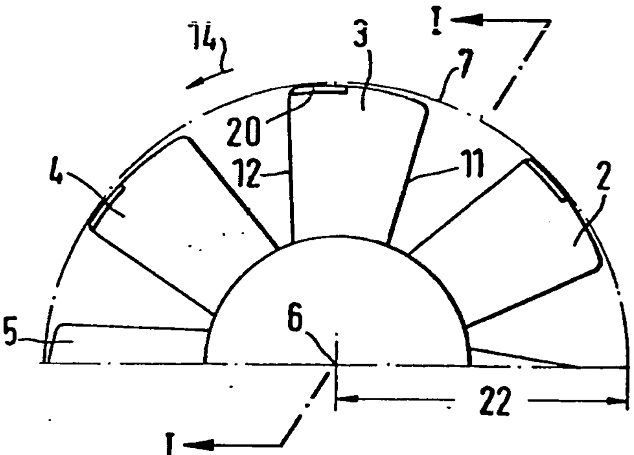

FIG. 2

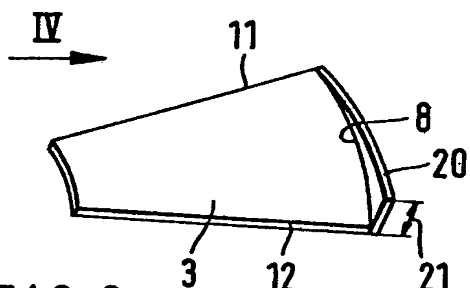

FIG. 3

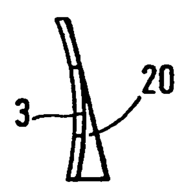

FIG. 4

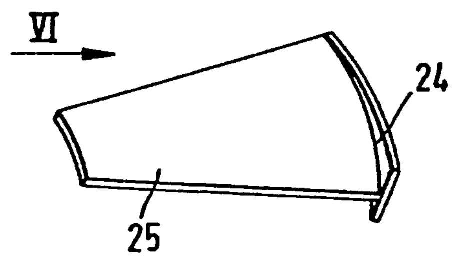

FIG. 5

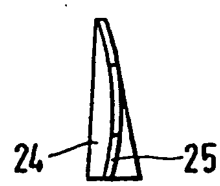

FIG. 6

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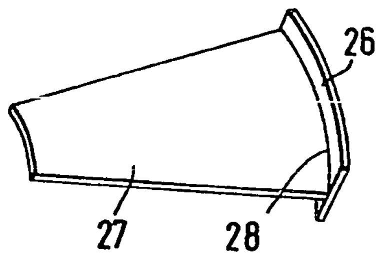
FIG. 7



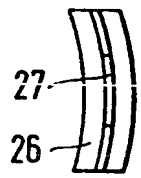
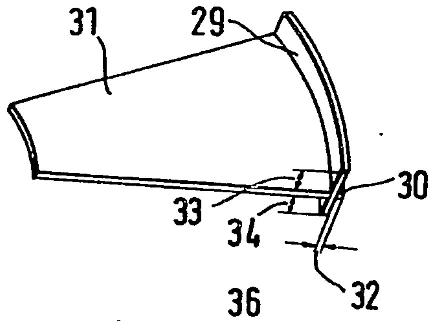


FIG. 8

FIG. 9



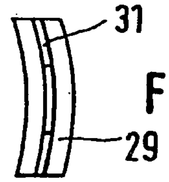


FIG. 10

FIG. 11

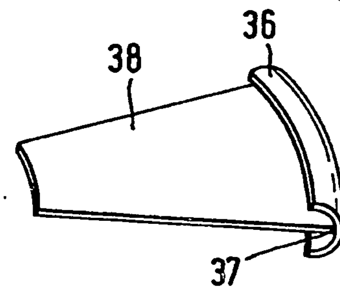
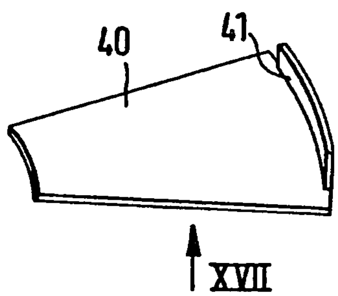


FIG. 12

FIG. 13



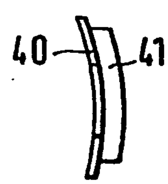
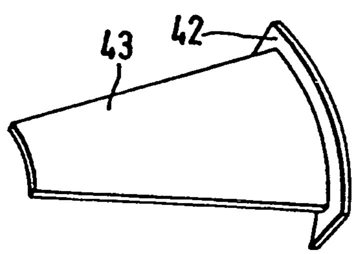


FIG. 14

FIG. 15



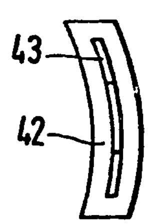


FIG. 16

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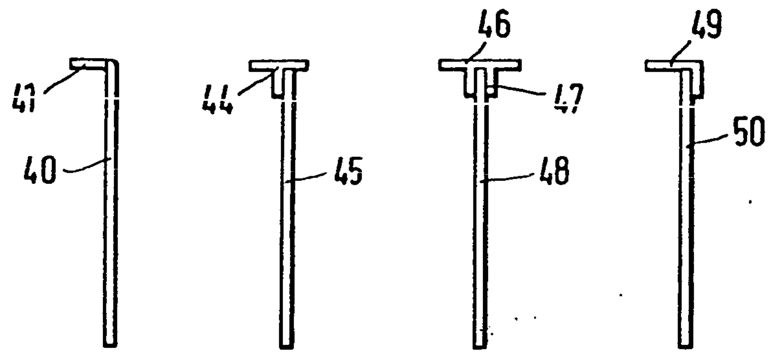

FIG.17 FIG.18 FIG.19 FIG.20

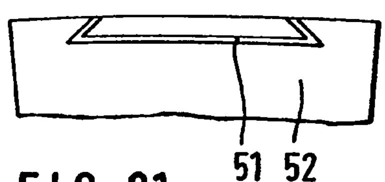

FIG.21

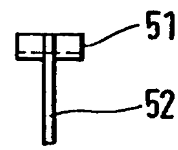

FIG.24

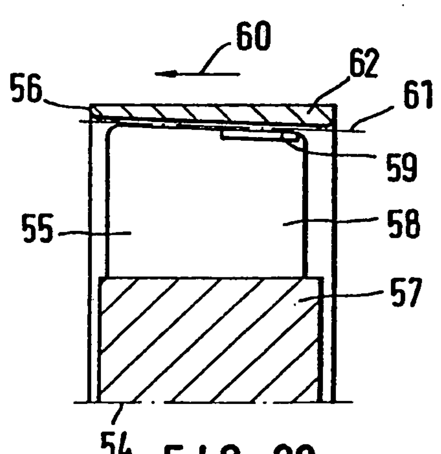

FIG.22

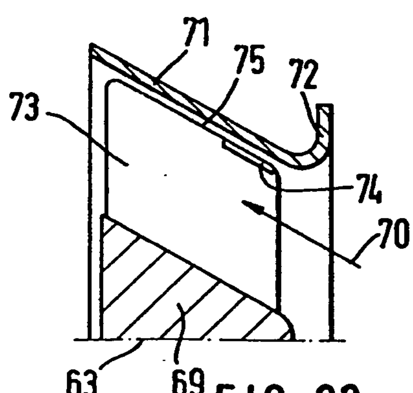

FIG.23

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SPECIFICATION
Linear Motor

The invention relates to impellers of the type having blades fixed in circumferentially distributed manner to a central hub and whose radially outer edges are positioned at a surface of revolution coaxial to the fan axis and defining a boundary of the delivery flow.

In a known impeller of this type, air can escape from the pressure side to the intake side at the radially outer edge of the fan blades and this impairs the delivery efficiency. If a casing coaxial to the impeller axis is provided for such an impeller, and narrowly embraces the fan blades along their radially outer edges whilst leaving a clearance, this impedes but does not prevent the loss flow. This loss flow can be stopped by a complete ring fixed to the radially outer edges of the fan blades, but this possibility cannot be used in many cases, because said ring becomes part of the impeller and must also be rotated. As a result, the moment of inertia of the impeller is considerably increased and frictional losses occur on the radially outer surface of the ring, so that it is only possible in special cases to advantageously provide impellers with such outer rings.

The object of the present invention is to improve the impeller of the aforementioned type so that, with minimum additional expenditure and with obviation of other flow disadvantages, the loss flow around the radially outer edges of the fan blades is prevented.

According to the present invention, in an impeller with blades fixed in circumferentially distributed manner to a central hub and whose radial outer edges extend to a surface of revolution coaxial to the impeller axis and defining a boundary of the delivery flow, there is provided at the radially outer edge of each blade a flow element which has a low resistance to the delivery flow and constitutes an obstacle to the compensating flow which tends to pass around the outer edge from the delivery side to the suction side.

The compensating flow between the delivery and suction sides at the radially outer edge of the blade tends to take place over the entire length of the end of the blade. However, it is at a maximum where the pressure differences are greatest, i.e. with conventional blade shapes in the front part of the blade, the term "front part" being understood to mean that portion which is directed counter to the flow direction, that is to say the edge against which the flow is directed. Account is then taken of the twist of the fan blade edge directed towards the suction side of the impeller. Thus, said flow element is in particular provided in the vicinity of the intake side blade edge. However, the flow element may advantageously extend into the rear portion of the blade, i.e. that portion on the delivery side. In the simplest case, the flow element is a web, for example a stamped sheet metal element, mounted on the blade at right angles to the major surface thereof. Particularly when the blade is itself a stamped sheet metal element, made for example of soft sheet steel, the flow element can be readily manufactured and fitted. In conjunction with a stamped sheet metal fan blade, the flow element is particularly effective aerodynamically.

An impeller of the invention, for example an axial impeller, may be used without a casing. However, it is preferably used in a fan with a casing coaxial with the impeller axis and which closely embraces the impeller at a clearance from the radially outer edge of the fan blade.

Some embodiments of the invention are hereinafter particularly described with reference to the accompanying drawings, wherein:—

Figure 1 is a cross-section of half of an axial impeller taken on the line I—I in Figure 2;

Figure 2 is an axial elevation viewed in the direction of the arrow II in Figure 1;

Figure 3 is a perspective view of a blade, according to Figures 1 and 2;

Figure 4 is an elevation of a development of the external blade edge with the flow element in cutout form, viewed in the direction of the arrow IV in Figure 3;

Figure 5 is a view similar to that of Figure 3 of a blade in a further embodiment differing from that of Figures 1 to 4 by the shape of the blade and of the flow element;

Figure 6 an elevation viewed in the direction of arrow VI of Figure 5;

Figures 7, 8, 9 and 10, 11 and 12, 13 and 14, and 15 and 16 are in each case views, similar to those of Figures 5 and 6, of respective further embodiments;

Figure 17 is an edge elevation viewed in the direction of arrow XVII of Figure 13;

Figures 18, 19 and 20 are in each case edge views of respective further embodiments;

Figure 21 is a side elevation of a blade of a further embodiment;

Figure 22 is a radial section of one half of a fan;

Figure 23 is a radial section of one half of another fan.

In Figure 1, 1 is a hub over whose circumference are approximately uniformly distributed a total of seven blades 2 to 5. The outer edgesof the blades extend up to a surface of revolution 7, indicated by broken lines, which is coaxial to the axis 6. The surface of revolution 7 in Figure 1 is a right cylindrical surface, but it can also have some other shape, e.g. a conical shape, like that shown for example in Figure 23.

The outer edge 8 merges, for example by rounded corners 9 and 10, into the downstream edge 11 or the upstream edge 12. Arrow 13 indicates the delivery direction. In accordance with the rotation direction indicated by arrow 13, upstream edge 12 faces the viewer of Figure 2 more than downstream edge 11. In the upstream area or each blade, a web-like flow member 20 is arranged along the outer edge 8 and specifically on the outer edge of the suction side of the blade end, approximately at right angles to the major

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surface of the blade. The flow member 20 is widest at the upstream edge 12, i.e. its width at right angles to the blade surface is greatest there and becomes less towards the downstream edge 11. The greatest width of the flow member 20 is 3 to 15%, preferably 8 to 10%, of the impeller radius indicated by the arrow 22. These size relationships have proved advantageous for all the embodiments described hereinafter.

In the embodiment according to Figures 1 and 2, the flow member 20 is arranged in the vicinity of the upstream edge 12 and on the suction side of the blade. However, flow member 20 can also be arranged on the delivery side of the blade i.e. the side remote from the viewer in Figures 1 and 2. Here again, the flow member is preferably arranged in the vicinity of the upstream edge 12.

Blades 2, 3, 4, and 5 may conveniently be stamped from flat sheet metal, but the invention can also be used with profiled blades produced in other ways. However, the invention has proved particularly effective in conjunction with flat fan blades stamped from sheet metal.

Figures 1 and 2 are shown to a scale of 1:2, i.e. half the actual size of a practical embodiment.

In the embodiment according to Figures 5 and 6, the flow member 24 extends at each side, i.e. to the delivery and suction sides on blade 25 and passes rearwards with decreasing width in accordance with Figures 1 to 4.

In Figures 7 and 8, the flow element 26 extends on each side of the blade 27 and has the same width over the entire length of outer edge 28.

According to Figures 9 and 10, the flow element 29 extends on each side of blade 31, but it offset radially with respect to outer edge 30 by the distance indicated by arrows 32. The distance indicated by arrows 32 is at the most the same as the width indicated by the double arrows 33, 34 by which flow element 29 projects at each side.

According to Figures 11 and 12, the flow element 36 extends over the entire circumferential length of the outer edge 37 of blade 38 and is curved inwards on each side.

According to Figures 13 and 14, blade 40 extends angularly in each direction beyond the flow element 41 fitted at only one side.

According to Figures 15 and 16, the flow element 42, provided on both sides, extends angularly in each direction beyond the blade 43.

As is apparent from Figure 17, flow element 41 is in one piece with the blade 40 made for example by bending a piece of sheet metal.

According to Figure 18, the flow element 44 is formed by an element of T-shaped cross-section mounted on the blade 45.

According to Figure 19, the flow element 46 is formed by an element of a somewhat T-shaped crosssection having a slot 47 into which is fitted the blade 48.

According to Figure 20, the flow element 49 is formed by an L-shaped element mounted on the blade 50.

According to Figure 21, the flow element 51 is an element engaged into the blade 52 in the manner of a dovetail joint.

Axial impellers according to the invention can be used in free standing manner, i.e. without a casing. However, it is more advantageous to provide a casing, as is for example the case with the fan 56 of Figure 22 which is equipped with an axial flow impeller 55. Impeller 55 is constructed in the same way as the impeller of Figure 1. The hub is denoted by 57, the blade by 58, the flow element by 59 and the flow direction by arrow 60. The broken line 61, corresponding to the broken line 7 of Figures 1 and 2, indicates the surface of revolution up to which the blades extend. This surface of revolution is surrounded at radial spacing by casing 62 which is coaxial to the axis 54 and which is circular cylindrical in Figure 22.

In the embodiment of Figure 23, the duct for the delivery is divergent in the direction of flow. The hub 69 is widened conically in the flow direction indicated by arrow 70 and correspondingly the stationary casing 71 is shaped like a frustum which is coaxial to fan axis 63 and which widens in the flow direction, and which has an outwardly curved intake flange 72. The fan blades are approximately trapezoidal and radially they fill the available space up to the casing surface 71 but leaving a clearance. On the delivery side of the fan blades, an as is shown for the blade 73, a web 74 is fitted as the flow element and extends along the outer edge 75 in the upstream region of the blade.

In all the embodiments, the flow elements for the delivery flow are constructed to have low resistance, so that they cause minimum interference to the delivery flow. The flow moves in the direction of flow arrows 13, 16 or 70 and specifically within the delivery flow duct (cf line 61') bounded externally by the surface of revolution 7 or 61 and/or by the outer edges of the blades. The flow elements are constructed as obstacles for the undesired compensating flow which tends to pass through the gap between the impeller and a casing surface or over the outer edge of the blades, i.e. they offer to it a maximum flow resistance. Therefore, they prevent the undesired gap flow, without impairing the desired delivery flow. It is to be noted that it is possible to suppress the loss flow with relatively limited expenditure on material and limited weight by using relatively small flow elements and which can be manufactured with a relatively small extra expenditure. They can advantageously be used with both axial and diagonal blowers.

Claims

1. An impeller with blades fixed in circumferentially distributed manner to a central hub and whose radial outer edges extend to a surface of revolution coaxial to the impeller axis and defining a boundary of the delivery flow, wherein there is provided at the radially outer edge of each blade a flow element which has a low resistance to the delivery flow and constitutes an obstacle to the compensating flow which

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tends to pass around the outer edge from the delivery side to the suction side.

2. An impeller, according to Claim 1, wherein the flow element is arranged on upstream edge of the blade.

3. An impeller, according to either of Claims 1 and 2, wherein the flow element is arranged on the suction side of the blade.

4. An impeller according to either of Claims 1 and 2, wherein the flow element is arranged on the delivery side of the blade.

5. An impeller, according to either of Claims 3 and 4, wherein the flow element extends along both the delivery and the suction side of the blade.

6. An impeller, according to any one of the preceding claims, wherein there is provided a casing coaxial with the impeller axis and embracing with clearance the radially outer edges of the blades.

7. An impeller, according to Claim 6, wherein the hub forming the radially inner boundary of the flow duct is conically flared in the delivery direction similarly to the casing forming the radially outer boundary of the flow duct.

8. An impeller, according to any one of the preceding Claims, wherein each blade is stamped from sheet metal.

9. An impeller substantially as described herein with reference to Figures 1—4, or 7—8, or 9—10, or 11—12, or 13—14, or 15—16, or 17 or 18, or 19, or 20, or 21, or 22 of the accompanying drawings.

10. A fan substantially as described herein with reference to Figure 22 or Figure 23 of the accompanying drawings.

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